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REFRACTIVE INDEX OF DIELECTRIC KCl SOLUTION IN PRESENCE AND IN ABSENCE OF ELECTRIC FIELD USING HOLLOW GLASS PRISM

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ABSTRACT

At room temperature refractive index of one, two, three and four molal dielectric KCl solution in absence as well as in presence of electric field was obtained using Spectrometer, Hollow glass prism and Monochromatic sodium source as a light source. It was found that refractive index of dielectric solution was greater in presence of electric field than in absence of electric field at each molal concentration. The increase in refractive index of medium occurred due to torque and force which acted upon electric dipole in order to conduct and reduce electric field inside the medium. Using hollow glass prism it was verified that refractive index of KCl solution increases with increase in molal concentration in presence as well as in absence of electric field.

KEYWORDS: Refractive index, Dielectric KCl, Electric field & Hollow glass prism

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Original Article

INTRODUCTION

Refractive index of 1, 2, 3 and 4 molal KCl solution in presence as well as in absence of electric field was obtained using hollow glass prism. Refractive index of medium was computed using Shuster's method and prism formula [3] [4]. Conducting Wires dipped in medium and Power supply were used to provide electric field in the medium.It was founded that refractive index of KCl solution at each molal concentration was greater in presence of electric field than in absence of electric field. When electric field was applied across a dielectric medium the electric dipole of polar molecule KCl experiences a torque ($N= p\times E$) and force $\nabla(p.E)$ to form a polarized medium [1]. The KCl medium between two metal wires was analogous to dielectric medium between two metal plates(capacitor). This medium further showed oxidation and reduction at anode and cathode respectively [5] and turned medium into pale yellow color shown in figure (1). The increase in refractive index of KCl solution in presence of electric field might be due to force acting on electric dipole of medium so as to conduct current in the external circuit.

Figure 1: Dielectric KCl solution turning Pale Yellow when kept in Electric Field for Long Time

EXPERIMENT

At room temperature 1, 2, 3 and 4 molal KCl solution were prepared separately. Using spirit level the prism table, collimator and telescope were aligned horizontally. Cross wire was adjusted on fine slit illuminated by monochromatic sodium source. Prism filled with one molal KCl solution was placed on prism table with its base parallel to collimator and telescope. By Shuster's method angle of minimum deviation was obtained [3]. The procedure was repeated five times to find mean of angle of deviation (∫m) and to reduce error. Substituting angle of prism A=60° and mean of angle of minimum deviation in prism formula

$$\mu = \frac{\sin\{[A+\int m]/2\}}{\sin[A/2]} \quad [4]$$

Reduces to equation $\mu = 2*\sin[(60+\int m)/2]$…….. (1)

Equation (1) is used to calculate refractive index of one molal KCl solution in absence of electric field. Similar procedure was followed to compute refractive index of 2, 3 and 4 molal KCl solution in absence of electric field. To obtain refractive index of KCl solution in presence of electric field the Power supply, two conducting wires, 1KΩ Resistance on resistance box and ammeter were used. Circuit was connected as shown in figure 2.

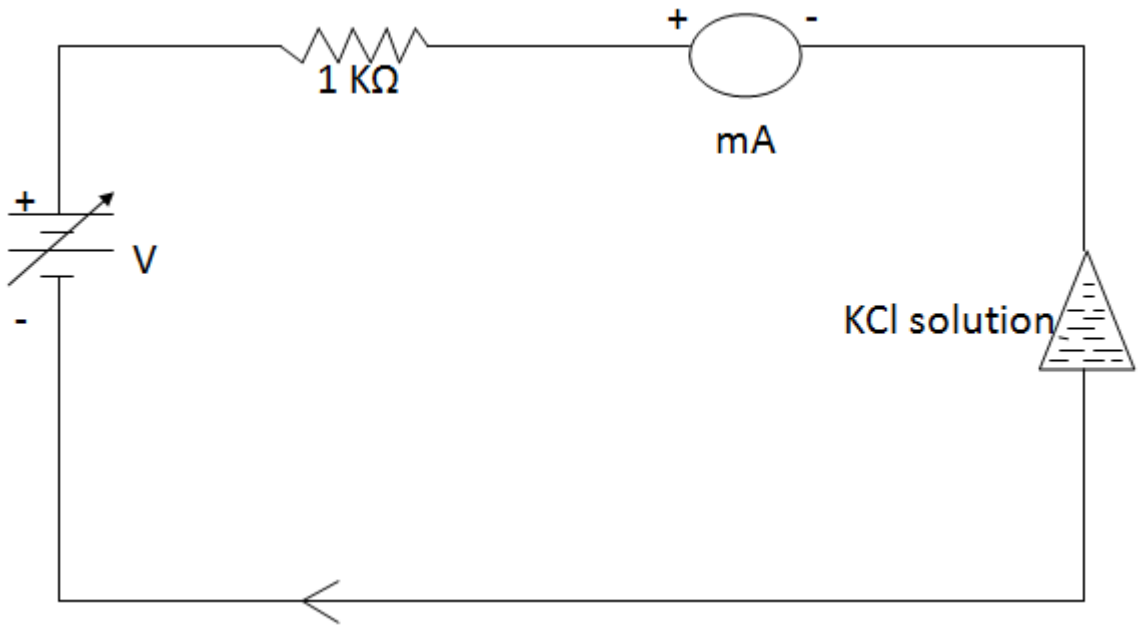

Figure 2: Circuit Diagram to apply Electric Field across KCl Solution

Wires were freely suspended in the solution. With help of power supply 13.2V was applied and current in the circuit was measured using Ammeter. Using the Shuster method and prism formula refractive index of 1, 2, 3 and 4 molal KCl solution in presence of electric field was calculated [3] [4].

Figure 3: Denotes experimental setup used to calculate refractive index of solution in presence of electric field.

Observation table are given below

1] One molal KCl solution in absence of Magnetic Field

Sr.	∫m Position		Direct Reading		Difference		Mean
	A'	B'	A	B	A'-A	B'-B	∫m
1	154°47'	334°04'	130°45'	310°34'	24°02'	23°30'	23°46'
2	142°56'	322°43'	118°18'	298°06'	24°38'	24°37'	24°37'30''
3	128°48'	308°39'	104°28'	284°16'	24°20'	24°23'	24°21'30''
4	117°06'	296°52'	92°41'	272°32'	24°25'	24°20'	24°22'30''
5	103°53'	283°42'	79°55'	254°45'	23°58'	23°57'	23°57'30''

∫m = 24°13'

μ = 2*sin{[A+∫m]/2}

μ = 1.3410

Hence refractive index of 1 molal KCl solution at room temperature is 1.3410

2] Two Molal KCl solution in absence of Magnetic Field

Sr.	∫m Position		Direct Reading		Difference		Mean
	A'	B'	A	B	A'-A	B'-B	∫m
1	94°57'	274°44'	69°55'	249°45'	25°02'	24°49'	24°55'
2	81°30'	261°22'	56°40'	236°05'	24°50'	25°17'	25°03'
3	66°50'	246°40'	41°47'	121°44'	25°03'	24°56'	24°59'
4	51°08'	231°13'	26°35'	206°37'	24°33'	24°36'	24°34'30''
5	30°39'	318°43'	14°02'	194°12'	24°37'	24°31'	24°34'

∫m = 25°05'

μ = 2*sin{[A+∫m]/2}

μ = 1.3522

Hence refractive index of 2 molal KCl solution at room temperature is 1.3522

3] Three molal KCl solution in absence of magnetic field:

Sr.	∫m position		Direct reading		difference		mean
	A'	B'	A	B	A'-A	B'-B	∫m
1	21°5'	192°25'	346°36'	166°47'	25°39'	25°38'	25°38'30''
2	0°	180°15'	234°24'	154°40'	25°36'	25°35'	25°35'30''
3	347°51'	168°09'	322°11'	142°32'	25°40'	25°37'	25°38'30''
4	334°09'	154°26'	308°33'	128°54'	25°36'	25°32'	25°34'

∫m = 25°36'30"

μ = 2*sin{[A+∫m]/2}

μ = 1.3589

Hence refractive index of 3 molal KCl solution at room temperature is 1.3589

4] Four molal KCl solution in absence of magnetic field

Sr.	∫m position		Direct reading		difference		mean
	A’	B’	A	B	A’-A	B’-B	∫m
1	125°28’	305°07’	99°26’	279°06’	26°02’	26°01’	26°01’30’’
2	109°22’	289°10’	83°34’	263°12’	25°48’	25°58’	25°53’
3	94°54’	274°36’	69°08’	248°58’	25°46’	25°38’	25°42’
4	85°20’	265°15’	59°33’	239°24’	25°47’	25°51’	25°49’
5	67°54’	247°49’	41°66’	221°18’	26°38’	26°31’	26°34’30’’

∫m = 26°

$\mu = 2*\sin\{[A+\int m]/2\}$

$\mu = 1.3639$

Hence refractive index of 4 molal KCl solution at room temperature is 1.3639

5] One Molal KCl solution in presence of electric field. V = 13.2 V and current flowing through circuit is 11 m A

Sr	∫m position		Direct reading		difference		mean
	A’	B’	A	B	A’-A	B’-B	∫m
1	66°18’	246°14’	41°37’	221°33’	24°41’	24°41’	24°41’
2	54°27’	234°31’	29°43’	209°51’	24°44’	24°40’	24°42’
3	41°02’	221°12’	16°14’	198°28’	24°48’	24°44’	24°46’
4	29°55’	210°04’	5°12’	185°30’	24°43’	24°34’	24°38’30’’
5	19°08’	199°19’	354°26’	174°43’	24°42’	24°36’	24°39’

∫m = 24°41’18”

$\mu = 2*\sin\{[A+\int m]/2\}$

$\mu = 1.3471$

6] Two Molal KCl solution in presence of electric field V=13.2V; I= 11.5m A

Sr	∫m position		Direct reading		difference		mean
	A’	B’	A	B	A’-A	B’-B	∫m
1	143°10’	322°53’	117°51’	297°30’	25°19’	25°23’	25°21’
2	128°06’	307°59’	101°48’	282°35’	25°18’	25°24’	25°21’
3	109°12’	289°0’	83°55’	263°41’	25°17’	25°19’	25°18’
4	95°13’	275°04’	69°50’	249°41’	25°23’	25°23’	25°23’
5	76°42’	256°35’	51°29’	231°22’	25°13’	25°13’	25°13’

∫m = 25°19’12”

$\mu = 2*\sin\{[A+\int m]/2\}$

$\mu = 1.3552$

7] Three Molal KCl solution in presence of electric field. V=13.2V; I=12m A.

Sr	∫m position		Direct reading		difference		mean
	A’	B’	A	B	A’-A	B’-B	∫m
1	37°0’	217°08’	11°01’	191°10’	25°59’	25°58’	25°58’30’’
2	22°57’	203°0’	356°54’	177°08’	26°03’	25°52’	25°57’30’’
3	8°12’	188°21’	342°07’	162°22’	26°05’	25°59’	26°02’
4	352°32’	172°40’	326°24’	146°39’	26°08’	26°01’	26°04’30’’
5	337°23’	157°34’	311°16’	131°33’	26°07’	26°01’	26°04’

∫m = 26°01’18”

μ = 2*sin{[A+∫m]/2}

μ = 1.3642

8] Four molal KCl solution in presence of electric field. V= 13.2V, I= 12m A.

Sr	∫m position		Direct reading		difference		mean
	A’	B’	A	B	A’-A	B’-B	∫m
1	116°03’	295°50’	89°32’	269°10’	26°31’	26°40’	26°35’30’’
2	101°46’	281°28’	75°10’	254°52’	26°36’	26°36’	26°36’
3	85°13’	265°02’	58°40’	238°33’	26°33’	26°29’	26°31’
4	71°20’	251°14’	44°42’	224°40’	26°38’	26°34’	26°36’
5	57°42’	237°46’	211°10’	31°8’	26°36’	26°34’	26°35’

∫m = 26°34’42”

μ = 2*sin{[A+∫m]/2}

μ = 1.3713

RESULTS AND DISCUSSIONS

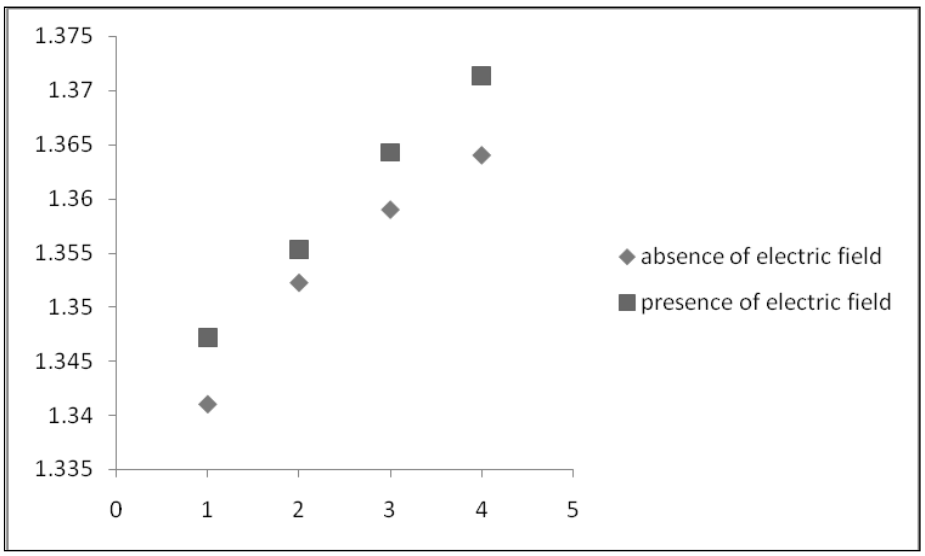

Figure 4: Graph of refractive index of KCl solution at different molal concentration in presence and in absence of electric field against molal concentration of medium

From graph, it was found that refractive index of medium at 1, 2, 3 and 4 molal concentration at room temperature was more in presence of electric field than in absence of electric field. When the wires dipped in KCl solution provided electric field the torque and force acting on electric dipole of polar molecule KCl caused polarization of medium [1]. Using hollow glass prism it was verified that refractive index of KCl solution increases with increase in molal concentration in presence as well as in absence of electric field [2]. The KCl medium between two metal wires was analogous to dielectric medium between two metal plates acting as a capacitor [1]. The movement of ions across the medium cause velocity of light in medium to decrease and thus increase in refractive index of medium was observed [6].

CONCLUSIONS

It was found that refractive index of dielectric solution was greater in presence of electric field than in absence of electric field at each molal concentration. The increase in refractive index of medium occurred due to torque and force which acted upon electric dipole in order to conduct and reduce electric field inside the medium [1]. Using hollow glass prism it was verified that refractive index of KCl solution increases with increase in molal concentration in presence as well as in absence of electric field [2].

FUTURE SCOPE

The conclusion can be verified for other dielectric solution at different applied voltages and different temperatures. Mathematical relation to obtaining refractive index of medium by knowing temperature and applied electric field can be derived by help of various graphs. We can change refractive index of a medium or can bend the light as per our convenience in the medium by just changing temperature and applied electric field.

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